EMERGENCE PHENOLOGY OF CADDISFLIES (TRICHOPTERA) FROM STREAMS IN ALGONQUIN PARK, ONTARIO, CANADA

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ABSTRACT

The emergence patterns and phenology of caddisflies (Trichoptera) were determined in two poorly dilute, headwater streams, Costello Creek and Mud Creek in Algonquin Provincial Park, Ontario, Canada. Adults of 53 species representing 29 genera and 14 families of Trichoptera were collected from April to October at five study sites. The frequency of emergence of the individual species showed a wide range of temporal and spatial variation. Numbers collected ranged from 61 m^2 at Mud Creek to 1232 m^2 $year^{-1}$ at Costello Creek. During the three-year study, an average of 78% of the total emergence of Trichoptera occurred between July and August ranging from 57% at Costello Creek to 95% at Mud Creek.

INTRODUCTION

There are often more species of trichopterans in a stream community than any other insect group with the exception of the Diptera. Many studies of the caddisfly group have been completed. These studies have focused on the ecology (Anderson and Bourne 1974, Elliott 1970, Mackay 1969, 1979, Malas and Wallace 1977, Resh 1976, 1982, Williams and Williams 1979) and life history of the caddisflies (Anderson and Wold 1972, Elliott 1971, McConnochie and Likens 1969, Mackay 1984, 1986, Resh 1976, Singh et al. 1984a). But few have examined the emergence patterns and phenology of the caddisfly fauna (Masteller and Flint 1980 a,b, 1984, Singh et al. 1984b, Harper 1990, Dobrin and Giberson 2003).

During the summer months of 1984 through 1986, samples of emerging insects were collected from two streams in Algonquin Provincial Park, Ontario. The data were collected to examine the effects of acid precipitation on stream communities (Hall and Ide 1987). This paper focuses on the emergence and phenology of several species of caddisflies from these Algonquin streams.

STUDY SITES

Algonquin Provincial Park is situated on pre-Cambrian Canadian shield where the rock consists of the granitic gneisses and schists characteristic of the Laurentian period. The two streams chosen for this study are located in the southeast corner of the park (Fig. 1). Costello Creek (45°35'N, 78°20'W) and Mud Creek (45°33'N, 78°15'W) are unpolluted, poorly buffered, low alkalinity

streams flowing through a coniferous and mixed hardwood forest.

Costello Creek (CC) arises from the outflow of Costello Lake and flows north to discharge into Lake Opeongo. The sampling site was located 36.5 m below the outflow. At this location, the width of the stream averages 2.5 m and the water is fast-flowing over a rubble and boulder bottom with a mean annual discharge ranging from 95.2 to 162.7 L/s. The traps were set over a 50 m section of the stream. The surrounding forest consists of a mixture of birch and conifers, replaced by alders along the stream banks.

Mud Creek (MC) originates at the outflow of a small lake and meanders south from its source into Galeairy Lake through an open beaver meadow and pond. Overflow from the beaver dam passes through a narrow channel (1 m wide) with a range in mean annual discharge from 7.7 to 26.7 L/s during 1984-86. The stream, which has a rubble bottom and is shaded by a dense growth of grasses and shrubs for most of the day, is subject to drying in the summer months. Mud Creek station MC1 is located in this section of the stream. MC2 was positioned 137 m downstream where the channel is 2.5 m wide, has a rubble bottom and passes between sloping banks that do not shade the water. The range for annual mean discharge was 8.5 to 31.5 L/s, somewhat faster than at MC1. Site MC3 lies 730 m downstream of the last of a chain of lakes where the rubble stream bed is about 2.5 m wide and the annual mean discharge ranged from 55.6 to 129.3 L/s. During 1985 and 1986, a fourth sampling site, MC5 was positioned downstream from MC3, close to Highway 60 where the stream is almost 3 m wide and flows through a clearing over a long, shallow riffle of fine gravel and sand at an annual mean discharge rate ranging between 281.8 to

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332.9 L/s. Stations MC1, MC2, MC3 and MC5 correspond to stations 1, 2, 3, and 6 sampled by Sprules (1947).

MATERIALS AND METHODS

Cone emergence traps were constructed to collect the insects (Fig. 2). Fibreglass window screening (1.7 mm mesh) was glued into a cone shape and fastened at the base to a 30 cm ring of 12 mm PVC tubing. A 7 cm length of 40 mm PVC tubing protruded through the apex of the cone and then through a hole into the bottom of a 1-L Nalgene bottle. Silicone was used to seal gaps around the tubing to prevent leakage of the small amount of 70% ethanol contained within the bottle. A string was attached to the top of the bottle and the trap was suspended over the stream on an overhead support so that the base floated on the water surface. Insects emerging into the trap moved through the apex of the funnel into the collecting bottle where they eventually fell into the ethanol. Specimens were collected weekly, the bottles were emptied into vials and fresh alcohol was added to the traps.

Each trap covered an area of 0.07 m^2. Eight traps were set up at CC1 during 1984 and 15 in 1985 and 1986. Each year 15 traps were positioned at MC1, and 10 at each of the other sites. Ten traps were set at MC5 during 1985 and 1986. All were left in place from mid-April until mid-October. Because of the nature of the stream bed at CC1, MC1, MC2 and MC3, the traps were positioned where there was enough open water between boulders. At MC5, the traps were positioned at random over the riffle.

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Maximum and minimum water temperatures were recorded at each site throughout the sampling period for each year. Measurements were taken daily during snowmelt in spring and weekly during the remaining summer and autumn emergence period.

Since Corbet (1964), Harper and Pilon (1970) and Harper (1973) have demonstrated that cumulative percentage curves are useful in illustrating emergence patterns, that method has been used in this study to supplement the histograms.

RESULTS AND DISCUSSION

Cone traps were used in this study because of the ease of service, since they required only weekly handling. In earlier studies, Ide (1940) and Sprules (1947) used 1 yd^2 cage traps and emptied them daily. In previous studies, investigators have compared the efficiencies of these traps. Emerging insects tend to avoid shaded areas (Kimmerle and Anderson 1967, Boerger 1981, Davies 1984) and insects emerging at the edge of the trap tend to move to the outside to avoid the shade. Morgan et al. (1963) postulated that small traps would enhance this effect because the edge to trapping area ratio is greater. Alternatively, Scott and Opdyke (1941) suggested that small traps are more efficient because the total area of shade is smaller. Both these studies were conducted in still water. Leuty (1988) found that the shading and edge effects are less important in running water environments where the insects have less control over the actual point of emergence.

In another sampling program conducted in the two streams in 1986 as part of the acid rain study, cage traps like those used by Ide (1940) and Sprules (1947) were utilized. The general pattern of emergence was the same as the results of this study although the larger cage traps caught more insects including isolated specimens of several additional rare species such as the late instar caddisfly (Leuty 1988). The small cone traps positioned in fast flowing water between boulders tend to miss these species since the larvae frequently move to shallow or protected areas before pupation.

Both Mud and Costello creeks are subject to high summer temperatures (Table 1). Over the three years of the study, sites CC1 and MC1 had the highest mean maximum and minimum temperatures because of the influence of upstream lakes. MC2 had the lowest temperatures because a small volume of cold water from a sphagnum bog flows continuously into Mud Creek about 45 m upstream of the sampling study. Mean maximum and minimum temperatures at MC3 and MC5 were similar and usually 1°C cooler than CC1 and MC1. The maximum difference among all sites ranged $2-3^\circ$C for all three years.

Fifty-three species representing 14 families of Trichoptera were found in the Costello and Mud Creek samples and is similar to total numbers of species (58) captured in emergence traps from rivers in subarctic Quebec (Harper 1990). Total numbers in this present study varied from $61/m^2$ at MC3 to $1232/m^2$ at CC1 and the frequency with which individual species occurred showed a wide range of variation from year to year and site to site (Table 2). Since the onset and duration of emergence was similar at all Mud Creek sites, the samples were pooled to show the emergence sequence and patterns.

Spatial Separation and Community Structure

Spatial separation of the aquatic stages of caddisflies varies in scale from microhabitat preferences to occupation of different stretches of the stream (Grant and Mackay 1969). No attempt was made to show separation of species by habitat at CC1 because the number of insects trapped was small. However, at the Mud Creek sites, there was evidence of large scale spatial separation. For example, the dominant hydropsychid species at MC1 was *Cheumatopsyche pettiti* (Table 2). Hydropsychids were relatively rare at MC2, *C. gracilis* was the most common representative at MC3 and MC5. It was unusual for a given species to be the commonest member of its family at any of the sites (Table 2). The variable physical structure of the stream at the different sites is undoubtedly a factor in this spatial separation. At all sampling sites, only the Hydroptilidae was well represented (with the exception of MC1 in 1985).

Spatial separation was evident in the relative abundance of various species at the Mud Creek sites. Temporal separation was less clearly defined although, in general, peak flight times of congeneric species were separated (Fig. 3; *Hydropsyche* spp.). Mackay (1972) postulates that this could be a mechanism to reduce competition of closely related species. The competition for food and space between species of different genera is probably less marked, particularly in productive forest streams where there is abundant allochthonous food material (Singh et al. 1984a).

Sex ratios varied from a preponderance of males in *Lype diversa* (Fig. 4) to

only a single male in *Hydropsyche* sp. (Fig. 3, MC86). The general trend in most species showed a slightly greater proportion of females (Figs. 3 and 4) which is a tendency commonly found in most species of caddisflies (Anderson and Wold 1972, Flannagan and Lawler 1972, Resh et al. 1975). In *C. aterrima*, the male/female ratio differed from site to site (Fig. 3). In Mud Creek, females far outnumbered the males. In Costello Creek, although females still outnumbered males, the ratio was closer to 1:1 and showed some variation from year to year. Masteller and Flint (1980a,b) observed the same phenomenon in caddisflies in Pennsylvania.

Few studies have investigated the cause of varying sex ratios but Singh et al. (1984b) suggest that either the trap efficiencies differ with respect to sex among the species, the microhabitat preference of juvenile stages in the stream is sex-linked, or the results reflect sex-specific mortality factors in the caddisfly community. Another possibility is that the emergence behaviour of males differs from that of females. Corbet (1966) pointed out that emergence traps also capture females surfacing after oviposition; therefore, parous females could be a factor in species where females predominate.

As a general rule, males of aquatic insects including caddisflies emerge before females (Hickin 1967, Masteller and Flint 1980a,b). In our results, only three species showed male protandry (Fig. 3, *H. slossonae*, Fig. 4, *M. sepulchralis,* and Fig. 5, *C. pettiti*). In most cases, it appeared that males and females emerge simultaneously (Figs. 3, 4, 5), but as the traps were only emptied weekly, this observation may be misleading.

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From year to year at CC1, the percentage representation of the two dominant families varied from 51.2% to 65% for the Philopotamidae and from 20.8% to 25.8% for the Hydropsychidae (Fig. 6, Table 2). In all three years, the MC1 community was dominated by hydropsychids and MC2 by the Hydroptilidae. MC3 showed the greatest variations with the Hydroptilidae the most numerous family in 1984. In 1985 and 1986, the Hydropsychidae became the most numerous and philopotamids and polycentropids also increased with the hydroptilids falling from 81% in 1984 to 18% in 1985 and 1986. The proportion of families at MC5 showed a variation in patterns of similarity and difference from the other sites. In both 1985 and 1986, the dominant family at MC5 was the Philopotamidae with 49% and 44% respectively, similar to the CC1 site. Additionally, the proportions of hydroptilids and hydropsychids showed similar patterns to MC1, MC2 and MC3. Differences, however, were evident in the increased proportion of the family Leptoceridae at MC5 relative to the other sites.

The number of adult insects trapped at MC1 was lower in 1984 and 1985 than in 1986 (Table 2). As at CC1, the percentage of hydropsychids in the population increased at this station in 1986 compared to 1984 and 1985 totals. *Chimarra aterrima* showed the same pattern. The Lepidostomatidae decreased due to the lower numbers of *Lepidostoma griseum* captured in 1985 and 1986. *Lype diversa* showed a marked increase. In 1986, the community was dominated by Hydropsychidae.

At MC2, the Hydroptilidae firmly dominated in 1984 (Fig. 6). A greater diversity of other caddisfly species was found in 1985 and the proportion of

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hydroptilids in the population fell. The results from 1986 were similar to those of 1985. The total catch of mayflies, stoneflies, and caddisflies at stations MC2 and MC3 can be compared with the results obtained by Sprules (1947; Table 3). For close to 60 years, the proportion of caddisflies to mayflies has remained at the same level while stoneflies have increased by 10%.

Between the 1984 and 1985 sampling seasons, beavers built a dam upstream from site MC3, dramatically altering the community structure (Fig. 6). In 1984, the dominant family was the Hydroptilidae. In 1985, the total number and diversity of adult Trichoptera greatly increased (Table 2). Hydropsychidae became dominant and there was a marked increase in other filter feeding species (Williams and Hynes 1973, Wallace and Malas 1976, Hildrew and Edington 1979, Elliott 1971) as would be expected, given the increase in planktonic material carried out of the beaver pond (Muller 1955). In 1986, the same pattern held. The 1984-86 results were compared with those of Sprules (1947; Table 3). At MC3, the percentage of stoneflies shows an increase but the proportion of mayflies has fallen dramatically and that of caddisflies has doubled.

The stream substrate at MC5, composed of finer gravel and sand, was less stable than at the other sites. Fewer species were found here but it was the only site where Leptoceridae and Molannidae were fairly common (Table 2). During both years, the most abundant family in the community was the Philopotamidae (due to high numbers of *Chimarra aterrima* captured).

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Sequence and Patterns of Emergence

Philopotamidae

Chimarra aterrima represented the most abundant of the 53 species collected in this study. Four species of Philopotamidae were captured in the traps (Table 2) but only *C. aterrima, C. socia* and *Dolophilodes distinctus* were present in sufficient numbers to permit examination of emergence patterns. *C. aterrima* was the commonest Philopotamid at CC1 and MC5 (Fig. 3) and *D. distinctus* at MC2 (Fig. 4). *C. socia* was also common at CC1 during 1984, less so in 1985 and no specimens were taken in 1986 (Table 2). *C. socia* has a shorter flight period than *C. aterrima* (Fig. 7), peaking in early July. *C. aterrima* (Fig. 3) has an extended flight period lasting from the beginning of June to October, with a major peak in August and a minor one in June. This pattern is suggestive of two generations or two cohorts within the same generation, although Williams and Hynes (1973) report that this species is univoltine in the Eramosa River in southern Ontario. *D. distinctus* (Fig. 4) has a unimodal emergence pattern that peaks in late July. A similar pattern in Pennsylvania was reported by Masteller and Flint (1984), who also observed an occasional spring cohort for this species.

Psychomyiidae

Only one specimen of *Psychomyia flavida* was taken at MC3 in 1986 (Table 2). *Lype diversa* (Table 2), a more common representative of this family, was found at all sites. The emergence pattern is unimodal, peaking in late June,

although a single specimen was captured in September (Fig. 4).

Polycentropidae

Four species of *Polycentropus*, two of *Nyctiophylax* and one each of *Phylocentropus* and *Neureclepsis* were trapped (Table 2). No species was common at any site but CC1 showed a greater diversity of species and higher numbers than the other stations. From the samples collected, indications are that *Polycentropus pentus* was first to emerge, followed by *P. confusus* and *P. maculatus* (Fig. 7). It was not possible to detail the emergence pattern from the data.

Hydropsychidae

This family was represented by 10 species — four of *Cheumatopsyche*, five of *Hydropsyche* and *Diplectrona modesta*. The flight periods of closely related species show a considerable overlap in many cases (Fig. 7). When cumulative emergence graphs are plotted for the most common species at each site, both differences and similarities are apparent (Fig. 8). The emergence of *Cheumatopsyche pettiti* is faster than that of *C. gracilis*, beginning at about the same time and ending earlier, but *C. campyla* shows a pattern which is very similar to that of *C. pettiti*. There were several species of Hydropsychidae at each site and though there was some evidence of scattered times of peak emergence (Figs. 3 & 5), under conditions of limited resources (e.g., dry stream bed, reduced food, etc.), there would appear to be the potential for

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considerable inter-specific competition. Dominance of various species changed from year to year at all sites, possibly reflecting the results of such competition.

Cumulative emergence curves for several species of *Cheumatopsyche* and *Hydropsyche* are shown (Fig. 8). There are indications of bivoltinism in some of the curves, but definite conclusions can not be drawn because numbers involved were too small. Mackay (1984) suggests that, as a general rule, abundant or dominant species of hydropsychids are bivoltine or multi-voltine in environments where summer temperatures exceed $25^{\circ C}$ for at least two months. Her conclusions are supported by the work of Cuffney and Wallace (1980) and Parker and Voshell (1982).

Rhyacophilidae

Four species of *Rhyacophilia* were trapped from the two streams (Table 2). All occurred in Mud Creek. The numbers captured were low but there were indications that *R. vibox* has a short, unimodal emergence period beginning in late May and peaking in early June, although in August, 1984, a single female showed in the samples (Fig. 4). This emergence pattern concurs with the results of studies in southern Ontario by Singh et al. (1984b). *R. fuscula* emerges from mid-June to September with peak emergence in late August (Fig. 7), a month later than in Pennsylvania (Masteller and Flint, 1984).

Glossosomatidae

A single, unidentified specimen of *Agapetus* was taken at MC3 in 1986 (Table 2). Apart from this, the family was represented by *Glossosoma nigrior* in both streams, and also by *G. intermedium* in Costello Creek. Neither species was common. Infrequent specimens of *G. nigrior* were taken from the first week in May throughout the sampling period (Fig. 7). Anderson and Wold (1972) reported *G. nigrior* to be bivoltine in the mid-west. Low numbers of *G. intermedium* were present in the samples in August and September.

Lepidostomatidae

Lepidostoma ontario was well represented in the Costello Creek samples for 1985 and 1986 (Table 2) but was uncommon in Mud Creek. The emergence period is short (Fig. 7) and unimodal as it is in Quebec (Mackay 1969). The peak occurred during the second week in June. *L. costalis* and *L. griseum* were less common but they were present in samples taken from most sites (Table 2). Ross (1944) stated that many species are rarely found together, though Anderson and Wold (1972) found four species of *Lepidostoma* at the same site. At Costello Creek, *L. costalis*
was present from mid-June to the end of July but emergence was extended until

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the end of August in Mud Creek. *L. griseum* was collected from mid-July to the third week in August (Fig. 7), a similar pattern to one exhibited in southern Ontario (Singh et al., 1984b). Masteller and Flint (1980a,b) and Mackay (1969) also report *L. griseum* emerges in August. It is possible that this latter species was more common than the samples indicate because the larvae are found most frequently in leaf pockets in slow-moving water, a habitat not well sampled by cone traps.

Molannidae

Molanna tryphena was rare in Costello Creek and at most of the Mud Creek stations (Table 2), occurring most frequently at MC5 where the bottom was of finer gravel and sand. Mackay (1969) found *M. blenda* in areas where thick piles of leaves had been overlying a sandy bottom. Adults were present in samples from the first week in June to the end of September in some years (Fig. 7). Numbers were too low to determine the emergence patterns (Fig. 4).

Leptoceridae

The Leptocerids were abundantly represented at MC5 (Table 2) and less common at CC1 and MC3. Two species of *Oecitis*, two *Ceraclea* and one *Triaenodes* were taken infrequently. The most common species was *Mystacides sepulchralis* (at MC5). Emergence began in mid-June and peaked rapidly from the third week in June to the first week in July. Isolated specimens were taken through the rest of July and August (Fig. 4). Resh (1976) reports that leptocerids have relatively short adult lives and a short emergence period. He postulates that

prolonged emergence periods reflect fluctuations in water temperature, with a direct correlation between the numbers emerging and the water temperature. The emergence graph of the water temperature at MC5 in 1986 (Table 2) shows this type of relationship.

Uenoidae

Neophylax oligius occurred in Costello Creek and *N. concinnus* in Mud Creek (Table 2). Both species had short emergence periods in late September (Fig. 7) as was also reported by Masteller and Flint (1984) in Pennsylvania.

Hydroptilidae

Of all caddisflies collected in the three-year study, *Hydroptila* was the second largest (Table 2). The numbers captured were large at each station in both Costello and Mud Creeks during all years except for 1984-85 at MC1. Unfortunately, keys to species within this family were not available. Roy and Harper (1975, 1979) recorded seven species of *Hydroptila* in nearby streams in Quebec. Species within this genus were captured from May to October, the same yearly duration of study within the Algonquin streams. In contrast *Agraylea* sp. (probably *Costello*) were found at several stations in Mud Creek. The adults of this species were collected in early August in Quebec (Roy and Harper 1975, 1979).

Brachycentridae

At each of CC1, MC3 and MC5, only single individuals of *M. sprulesi* were collected. This species emerged from June to August in Quebec (Roy and Harper 1975, 1979).

Phryganeidae

Ptilostomis ocellifera and *B. crotchi* were captured in both streams in low numbers (Table 2). Both species have been recorded emerging from streams in Quebec from June through September (Roy and Harper 1975, 1979).

Limnephilidae

Anabolia bimaculata, *Pycnopsyche scabripennis* and *Platycentropus radiatus* occurred in Mud Creek only. *P. guttifer* and *P. limbata* were collected in both Costello and Mud Creeks. However, for all species, numbers were too low to determine their phenologies. Several researchers have reported that the adults of these species emerge from late June to September in Quebec (Roy and Harper 1975, 1979) and June to August in Michigan (Leonard and Leonard 1949). *P. guttifer* has been captured as late as October in the above locations.

Many researchers have reported that the most intensive portion of the flight periods of most species of trichopterans falls in July and August (Morse and Blickle, 1953, McConnochie and Likens, 1979, Masteller and Flint, 1980a,b, Harper 1990). The data from Algonquin Park supports this conclusion. An

average of 78.3% of the total emergence took place during this time period, ranging from 57% in Costello Creek during 1985 to 95% in Mud Creek during 1984.

SUMMARY

The emergence patterns of adult caddisflies were quantified at the five sampling stations within two streams in Algonquin Park during 1984-86. In general, the greatest number of caddisfly species within a year occurred at CC1 with a progressive increase from 1984 to 1986. The number of emerging species was variable per year at the four Mud Creek sites with the lowest (8 species) collected in 1984 at MC3 and the highest (29 species) at the same location in 1985. At all five sites, for all years combined, the greatest total number of emerging caddisfly species occurred at CC1 and the lowest at MC3. There was a progressive decrease for combined total numbers of emerging species at MC1 to MC3 but increased again at MC4. For all stations combined, the total number of emerging insects progressively increased from 1984 to 1986.

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Table 1. Weekly maximum and minimum water temperatures from mid-April to October 1984-86. CC184 represents Costello Creek, site 1, 1984 and MC586 is Mud Creek, site 5, 1986.

	CC184	CC185	CC186	MC184	MC185	MC186	MC284	MC285	MC286	MC384	MC385	MC386	MC585	MC586
Mean Maximum	21.2	21	20.1	20.2	21.9	22.7	17.7	17	19.5	21.5	19.6	22	19.8	21.8
Mean Minimum	15.5	14.8	15.3	15.2	13.7	16.8	12.3	11.2	11.8	14.3	14.5	13.4	14	14.4
Mean Temperature	18.4	17.9	17.7	17.7	17.8	19.7	15	14.1	15.6	17.9	16.9	17.7	16.9	18.1

Table 2. Number of Trichoptera species (per m^2) by site and year.

	CC1			MC1			MC2			MC3			MC5		Totals		
	84	85	86	84	85	86	84	85	86	84	85	86	85	86	84	85	86
Philopotamidae																	
Dolophilodes distinctus (Walker)	2	-	2	-	-	-	3	39	19	1	12	-	-	-	6	51	21
Chimarra aterrima Hagan	406	175	705	2	2	11	3	8			7	15	134	172	411	326	903
C. socia Hagan	141	91	-	-	-	-	-	-	-	-	-	-	-	-	141	91	
C. obscura (Walker)	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2	3
Psychomyiidae																	
Psychomyia flavida Hagan	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Lype diversa (Banks)		9	9	3	17	12	-	-	8	2	6	1	1	2	5	33	32
Polycentropodidae																	
Polycentropus cinereus (Hagan)	1	2	4	-	-	11	-	-	1	-	-	2	-	-	1	2	18
P. confusus Hagan	13	11	12		1	1	1	1		1	3	2	10	-	15	26	15
P. maculatus Banks	8	3	1	-	-	-	-	2	3	-	1	1	2	7	8	8	12
P. pentus Ross	5	12	8	-	1	1	1	1	2	1	-	-	-	1	7	14	12
Neureclepsis crepuscularis (Banks)	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1	-
Phylocentropus placidus (Banks)	-	1	2	-	-	-	1	4	-	-	4	1	-	1	1	9	4
Nyctiophylax moestus Banks						1		3	1		2			2	-	5	4
N. vestitus (Hagan)	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Hydropsychidae																	
Cheumatopsyche campyla Ross	7	17	29	-	-	127	-	-	3	-	-	11	-	32	7	17	202
C. gracilis (Banks)	55	12	56	14	2	57		2			27	6	12	21	69	55	140
C. minuscula (Banks)	4	29	21	-	-	3	-	-	2	-	-	-	-	-	4	29	26
C. pettiti (Banks)	73	7	25	17	13	157	-	-	-	-	9	17	9	7	90	38	206
Diplectrona modesta Banks	1	-	4	-	-	-	1	7	-	1	1	-	-	-	3	8	4
Hydropsyche betteni Ross	30	13	14	1	20	29	1	8	4	-	9	5	-	-	32	50	52
H. sparna Ross	36	25	81	-	1	7	-	-	1	-	-	1	-	1	36	26	91
H. ventura Ross	-	-	-	-	6	-	-	8	-	-	8	-	1	-	-	23	-
Hydropsyche sp.	12	6	9	13	2	44	1		2		6	19	-	-	26	14	74
H. slossonae Banks	-	-	41	-	-	1	-	2	-	-	-	-	-	-	-	2	42
Rhyacophilidae																	
Rhyacophila fuscula (Walker)	9	5	7	-	-	-	-	1	-	-	-	1	-	-	9	6	8
R. vibox Milne	-	2	8	-	2	-	-	17	17	-	11	-	-	-		32	25
R. vuphipes Milne	3	-	-	-	-	1	-	-	3	3	-	-	-	-	6	-	4
R. carolina Banks	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-

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Table 2. (Cont'd)

	CC1			MC1			MC2			MC3			MC5		Totals		
	84	85	86	84	85	86	84	85	86	84	85	86	85	86	84	85	86
Glossosomatidae																	
Agapetus sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Glossosoma nigrior Banks	2	5	27	-	-	-	-	8	5	-	6	-	-	-	2	19	32
G. intermedium (Klapalek)	11	1	-	-	-	-	-	-	-	-	-	-	-	-	11	1	-
Brachycentridae																	
Micrasema sprulesi Ross	1	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	2
Lepidostomatidae																	
Lepidostoma costale (Banks)	-	3	1	3	5	-	2	12	-	3	5	1	1	-	8	26	2
L. griseum (Banks)	-	9	-	11	1	7	3	2	1	2	2	3	-	3	16	14	14
L. ontario Ross	3	61	49	-	-	2	1	-	1	-	-	-	-	-	4	61	52
Limnephilidae																	
Anabolia bimaculata (Walker)	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	2	-
Pycnopsyche guttifer (Walker)	-	1	-	-	-	3	-	-	-	-	1	-	-	-	-	2	3
P. limbata (McLachlan)	-	1	3	-	-	1	-	1	1	-	2	4	-	10	-	4	19
P. scabripennis (Rambur)	-	-	-	-	2	-	-	1	1	-	2	-	21		-	26	1
Platycentropus radiatus (Say)	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Uenoidae																	
Neophylax concinnus McLachlan	-	-	-	1	1	-	1	-	3	-	-	-	-	-	2	1	3
N. oligius Ross	11	3	14	-	-	-	-	-	-	-	-	-	-	-	11	3	14
Phryganeidae																	
Ptilostomis ocellifera (Walker)	-	-	-	1	-	4	-	-	1	-	1	-	1	1	1	2	6
Banksiola crotchi (Banks)	-	2	-	-	3	-	-	-	-	-	1	-	-	-	-	6	-
Hydroptilidae																	
Hydroptila sp.	12	17	70	1	-	30	95	53	30	47	22	22	43	52	155	135	204
Agraylea costello?	-	-	-	-	-	-	-	10	-	-	5	1	8	-	-	23	1
Molannidae																	
Molanna tryphena Betten	-	-	1	-	-	3	1	2	2	-	2	-	8	21	1	12	27
Leptoceridae																	
Oecetis avara (Banks)	3	-	13	1	-	6	-	-	-	-	4	3	4	15	4	8	37
O. inconspicua (Walker)	7	3	1	-	1	5	-	-	-	-	3	-	6	3	7	13	9
Ceraclea transvera (Hagan)	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
C. diluta (Hagan)	1	2	4	-	-	-	-	-	-	-	-	-	2	3	1	4	7
Mystacides sepulchralis (Walker)	-	-	-	-	-	-	-	-	1	-	1	-	11	39	-	12	40
Triaenodes tardus Milne	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Totals (#/m²)	858	530	1232	69	81	527	116	193	112	61	164	119	275	394	1104	1243	2384
Number of species found	26	30	32	13	19	24	15	24	23	8	29	22	18	20	34	45	45
Total number of species all years		39			32			34			37			26		53	

Table 3. Percentage composition of stoneflies (Plecoptera), mayflies (Ephemeroptera) and caddisflies (Trichoptera) collected in emergence traps at Mud Creek, site 2, 1939 (MC239) and Mud Creek, site 3, 1940 (MC340) together with total numbers collected at the same locations during 1984-86.

	MC239	MC284	MC285	MC286	80s Avg	MC340	MC384	MC385	MC386	80s Avg
Plecoptera	41.3	50.1	52.4	51.5	51.3	25.6	62.6	21.7	11.1	42.2
Ephemeroptera	31.3	26.6	34.9	27.7	29.7	59	22.5	29.1	26.1	25.9
Trichoptera	27.4	23.3	17.2	20.8	20.4	15.4	14.8	39.2	62.8	33.3
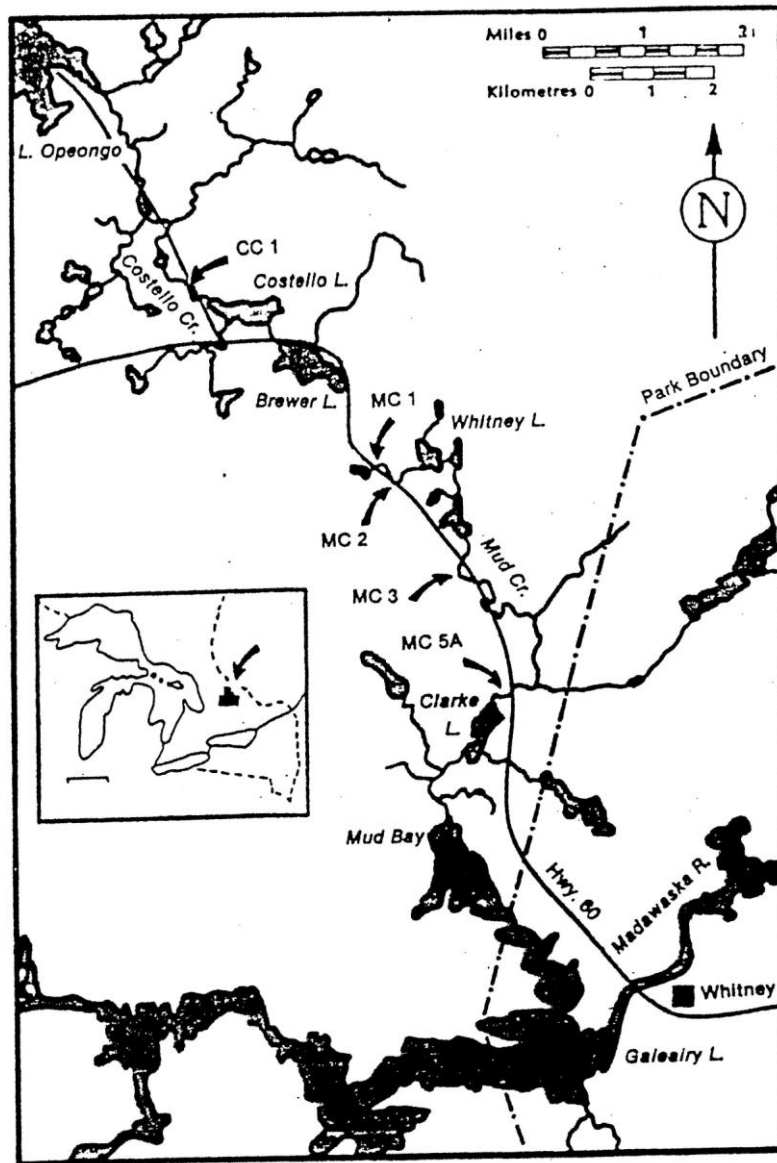
Figure 1: Map of southeastern portion of Algonquin Park
showing Costello Creek (CC) and Mud Creek (MC) sampling
sites.

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Figure 2: Diagram of cone trap used to collect adult insects.

10cm

Figure 3: Weekly emergence patterns of male and female Trichoptera from Mud Creek and Costello Creek during 1984-86.

Figure 4: Weekly emergence patterns of male and female
Trichoptera from two Algonquin Park streams.

Figure 5: Weekly emergence patterns of male and female Trichoptera from two Algonquin Park streams.

CC1

Philopotamidae 65.0%
Limnephilidae 1.3%
Leptoceridae 1.3%
Hydroptilidae 1.4%
Glossosomatidae 1.5%
Polycentropodidae 3.2%
Hydropsychidae 25.8%
1984

Philopotamidae 51.2%
Glossosomatidae 1.1%
Psychomyiidae 1.7%
Hydroptilidae 3.3%
Polycentropodidae 5.5%
Lepidostomatidae 14.0%
Hydropsychidae 20.8%
1985

Philopotamidae 58.3%
Limnephilidae 1.4%
Leptoceridae 2.0%
Glossosomatidae 2.2%
Polycentropodidae 2.4%
Lepidostomatidae 4.1%
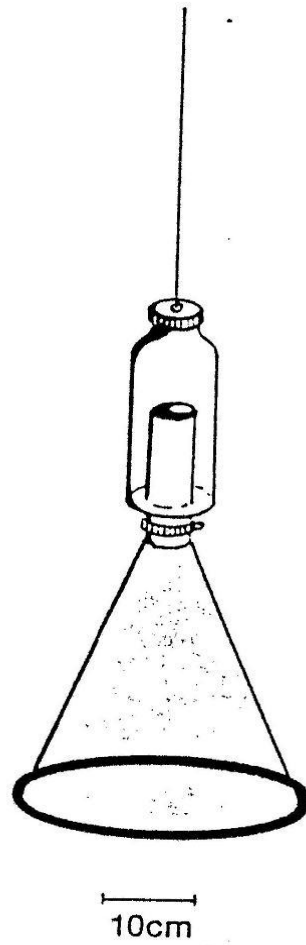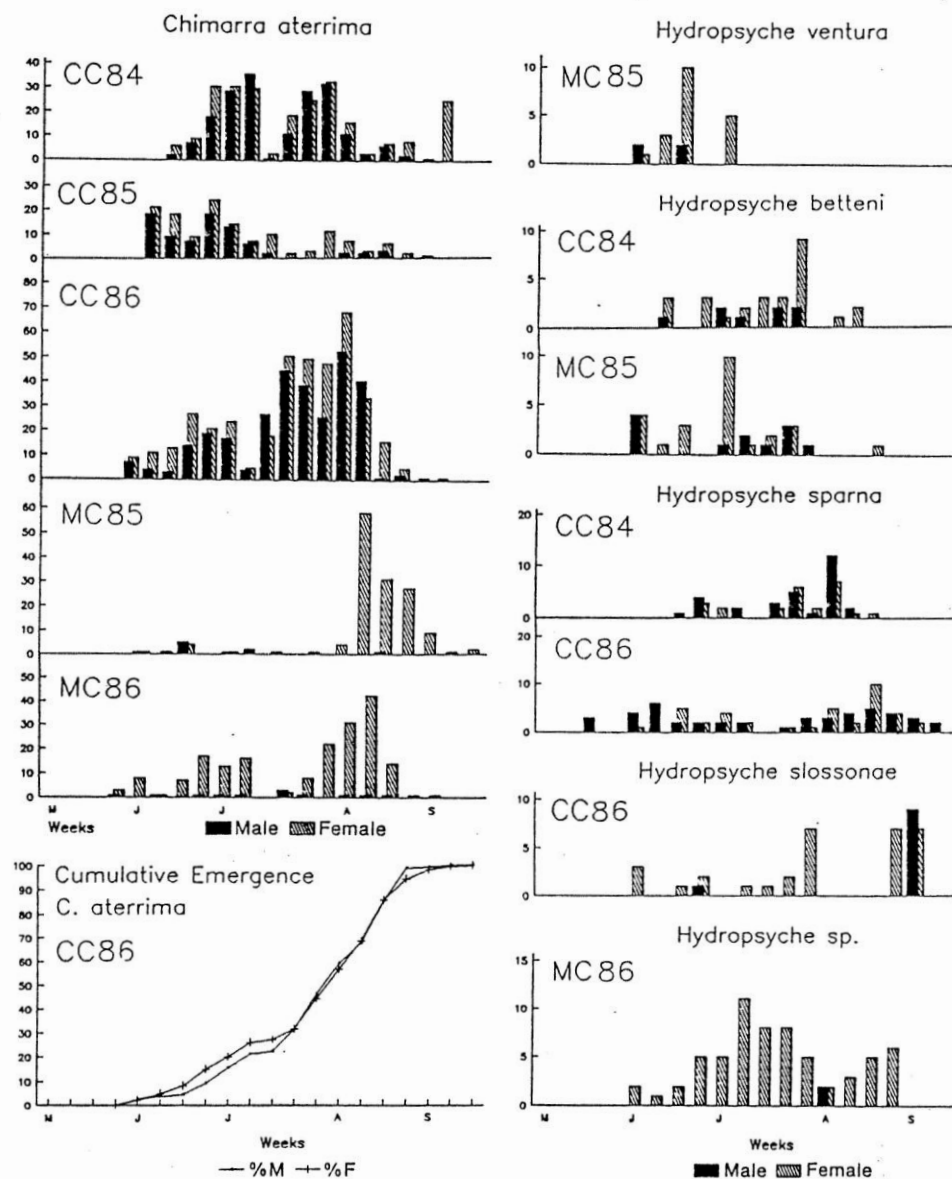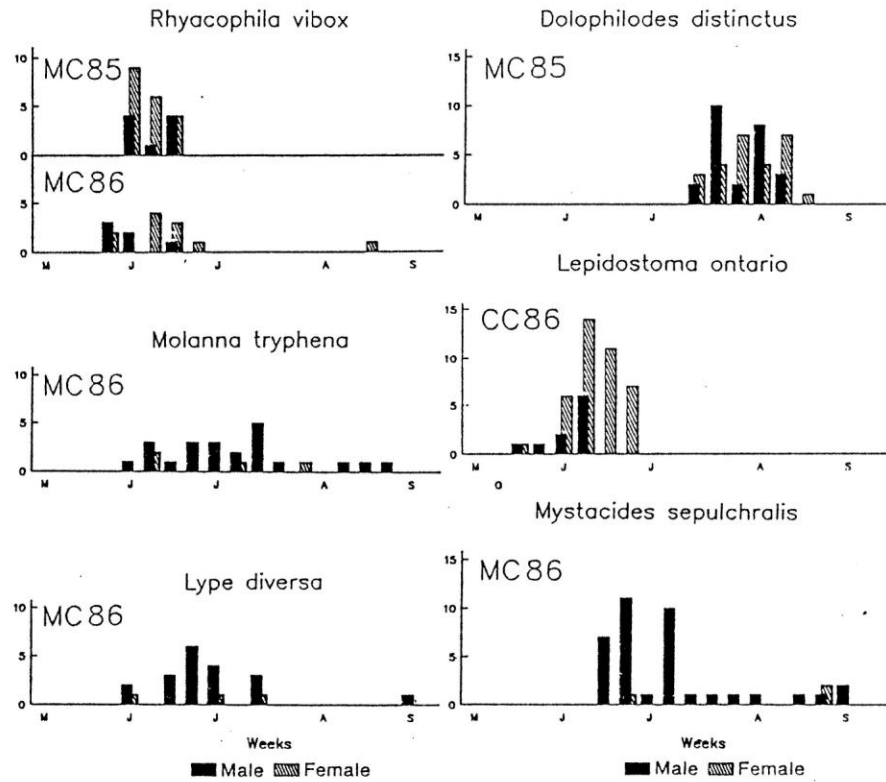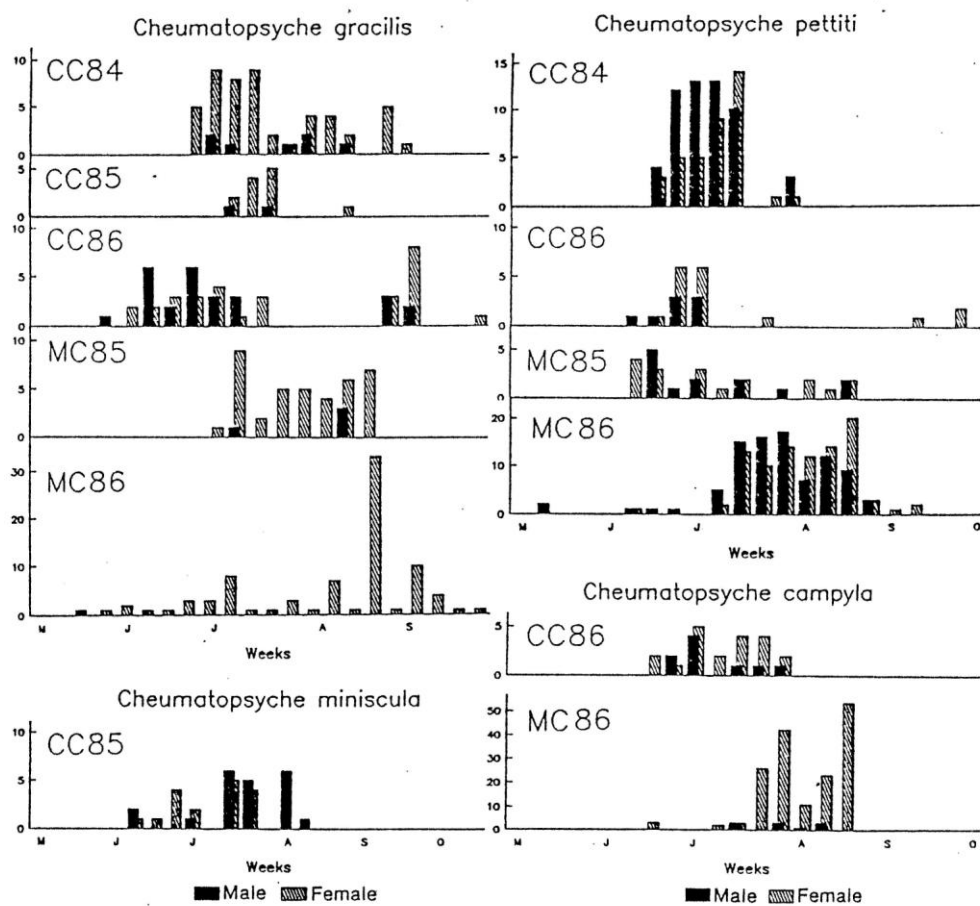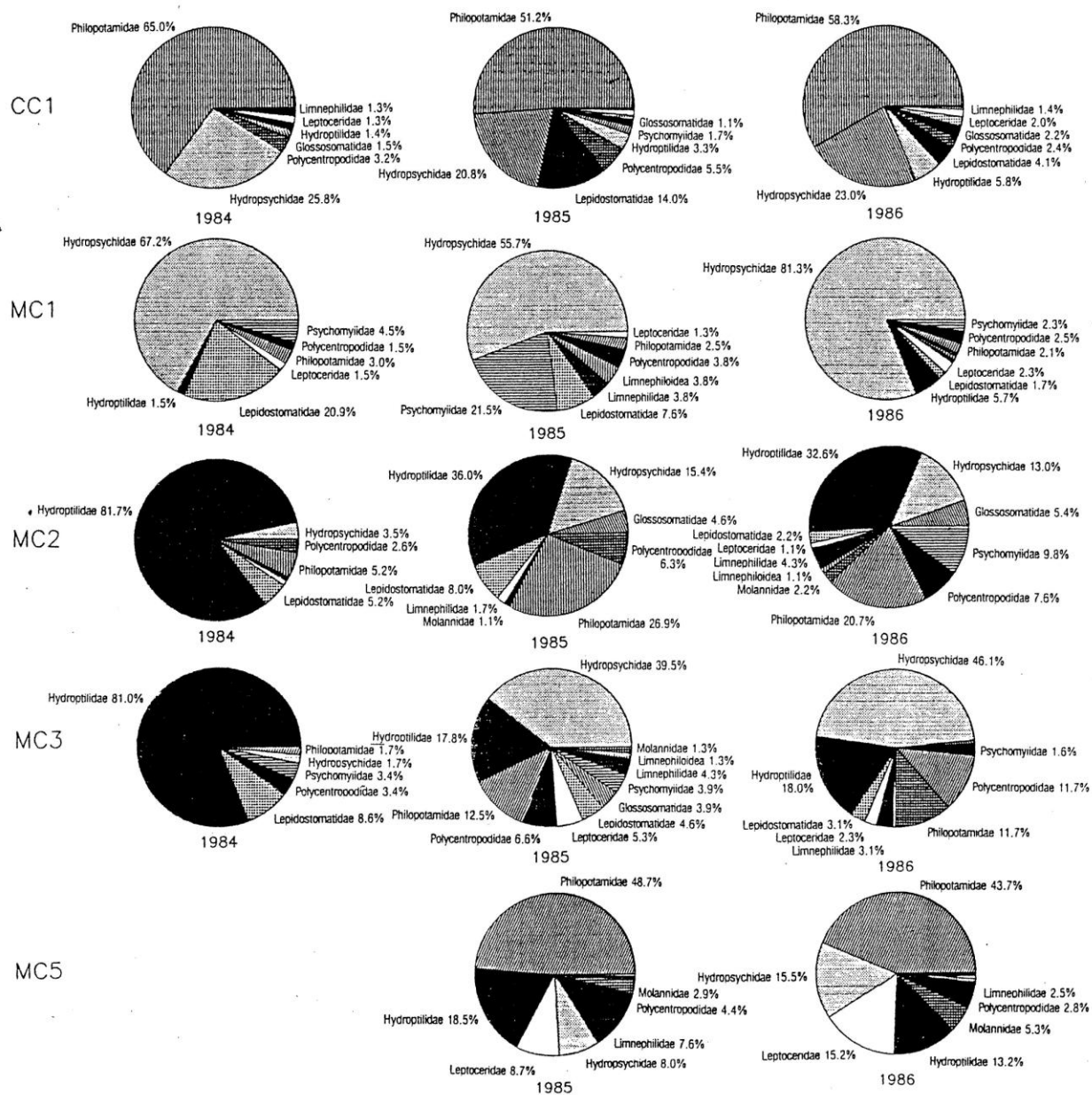Hydroptilidae 5.8%
Hydropsychidae 23.0%
1986

MC1

Hydropsychidae 67.2%
Psychomyiidae 4.5%
Polycentropodidae 1.5%
Philopotamidae 3.0%
Leptoceridae 1.5%
Hydroptilidae 1.5%
Lepidostomatidae 20.9%
1984

Hydropsychidae 55.7%
Leptoceridae 1.3%
Philopotamidae 2.5%
Polycentropodidae 3.8%
Limnephiloidea 3.8%
Limnephilidae 3.8%
Psychomyiidae 21.5%
Lepidostomatidae 7.6%
1985

Hydropsychidae 81.3%
Psychomyiidae 2.3%
Polycentropodidae 2.5%
Philopotamidae 2.1%
Leptoceridae 2.3%
Lepidostomatidae 1.7%
Hydroptilidae 5.7%
1986

MC2

Hydroptilidae 81.7%
Hydropsychidae 3.5%
Polycentropodidae 2.6%
Philopotamidae 5.2%
Lepidostomatidae 5.2%
Lepidostomatidae 8.0%
1984

Hydroptilidae 36.0%
Hydropsychidae 15.4%
Glossosomatidae 4.6%
Lepidostomatidae 2.2%
Polycentropodidae 6.3%
Leptoceridae 1.1%
Limnephilidae 4.3%
Limnephiloidea 1.1%
Molannidae 2.2%
Limnephilidae 1.7%
Molannidae 1.1%
Philopotamidae 26.9%
1985

Hydroptilidae 32.6%
Hydropsychidae 13.0%
Glossosomatidae 5.4%
Psychomyiidae 9.8%
Polycentropodidae 7.6%
Philopotamidae 20.7%
1986

MC3

Hydroptilidae 81.0%
Hydroptilidae 17.8%
Philopotamidae 1.7%
Hydropsychidae 1.7%
Psychomyiidae 3.4%
Polycentropodidae 3.4%
Lepidostomatidae 8.6%
1984

Hydropsychidae 39.5%
Molannidae 1.3%
Limneohilidae 1.3%
Limnephilidae 4.3%
Psychomyiidae 3.9%
Glossosomatidae 3.9%
Lepidostomatidae 4.6%
Philopotamidae 12.5%
Polycentropodidae 6.6%
Leptoceridae 5.3%
1985

Hydropsychidae 46.1%
Psychomyiidae 1.6%
Polycentropodidae 11.7%
Hydroptilidae 18.0%
Philopotamidae 11.7%
Lepidostomatidae 3.1%
Leptoceridae 2.3%
Limnephilidae 3.1%
1986

MC5

Philopotamidae 48.7%
Hydropsychidae 15.5%
Molannidae 2.9%
Polycentropodidae 4.4%
Hydroptilidae 18.5%
Limnephilidae 7.6%
Leptoceridae 8.7%
Hydropsychidae 8.0%
1985

Philopotamidae 43.7%
Limnephilidae 2.5%
Polycentropodidae 2.8%
Molannidae 5.3%
Leptoceridae 15.2%
Hydroptilidae 13.2%
1986

Figure 6: Proportion of individuals collected within nine families from Costello Creek and Mud Creek during 1984 – 86.
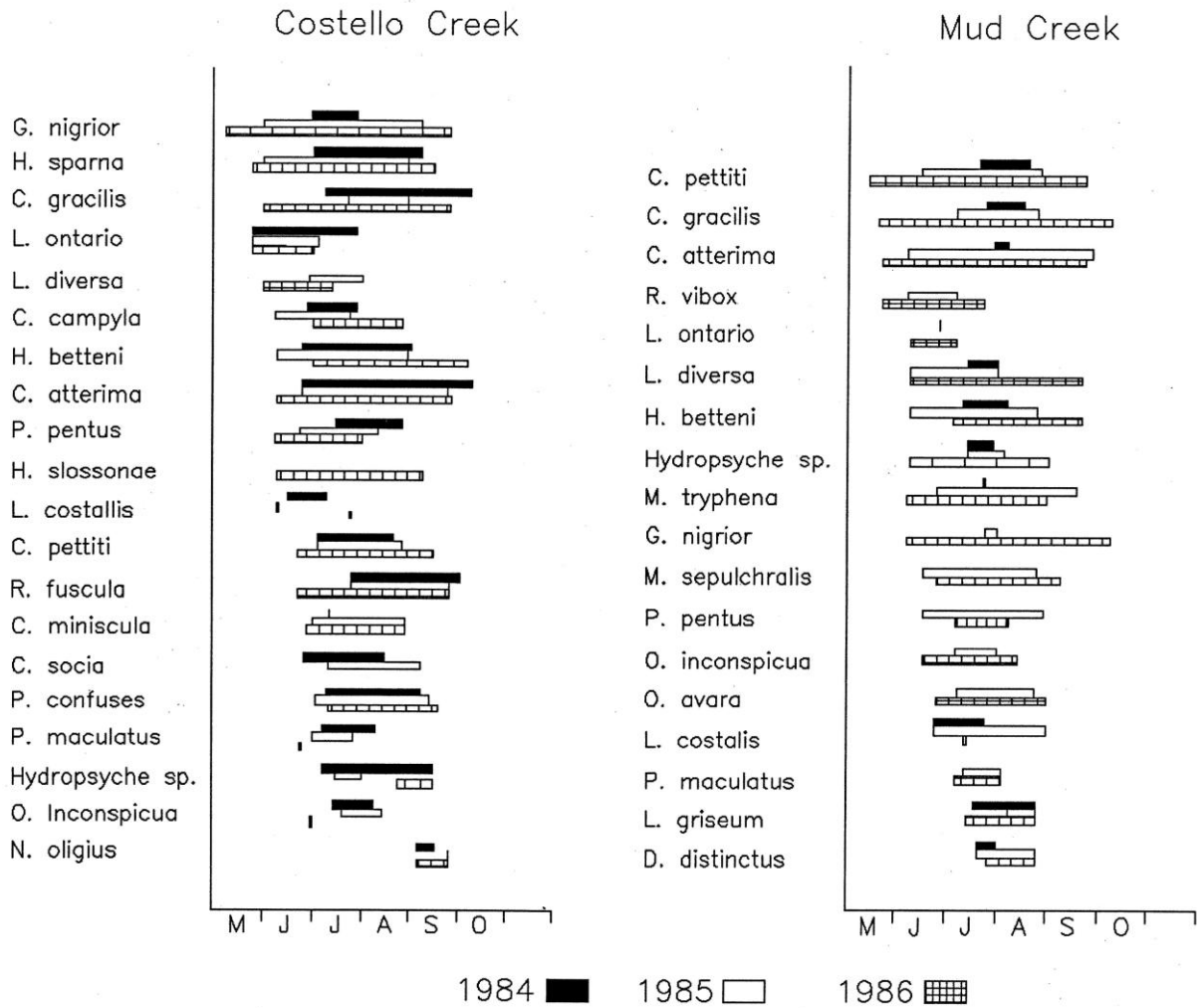
Figure 7: Emergence sequence of selected Trichoptera from Costello Creek and Mud Creek during 1984-86.
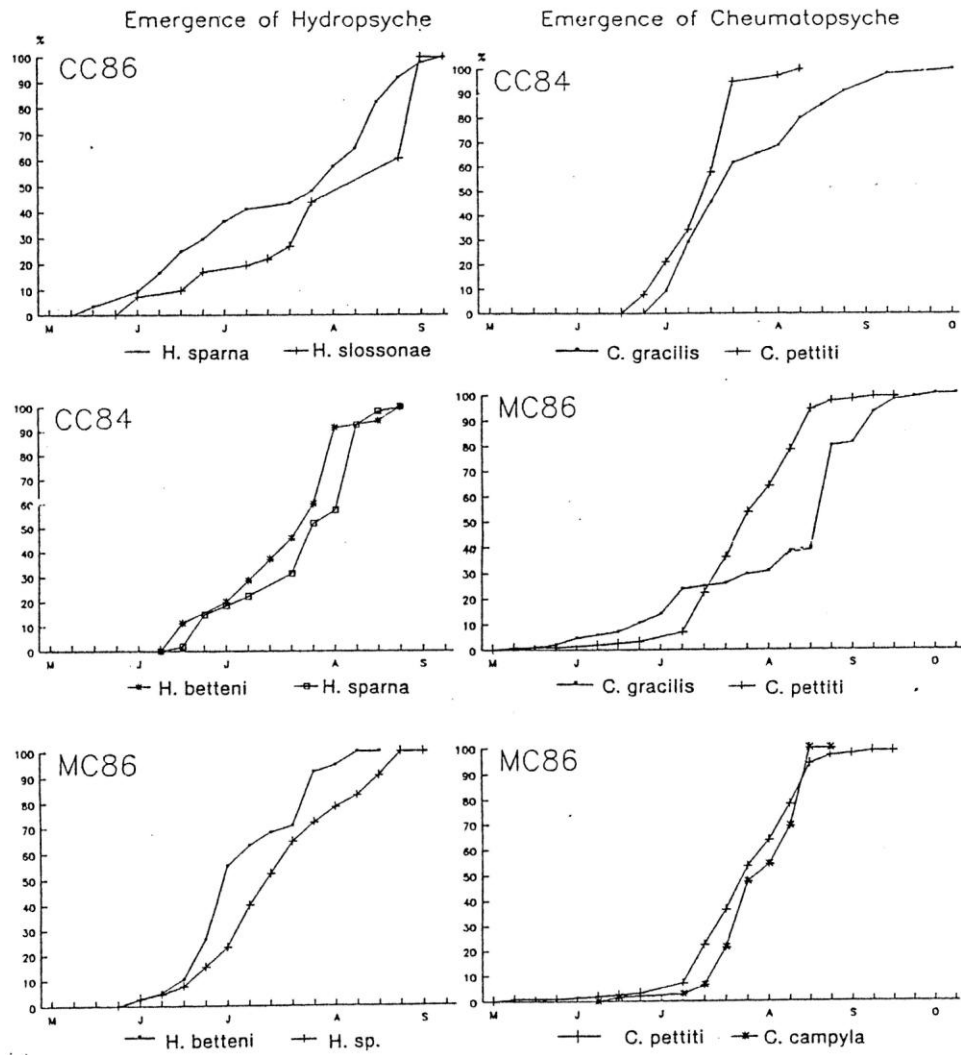
Figure 8: Cumulative emergence patterns of selected
Trichoptera within the family Hydropsychidae from Costello
Creek and Mud Creek during 1984 and 1986.

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